Title: **An Electronic Adaptive Swap-Shift Control for an Automatic Transmission for Automotive Vehicles**
First Named Inventor: **Ihab Soliman**
Atty. Docket No.: **FMC1624PUS/202-1442**

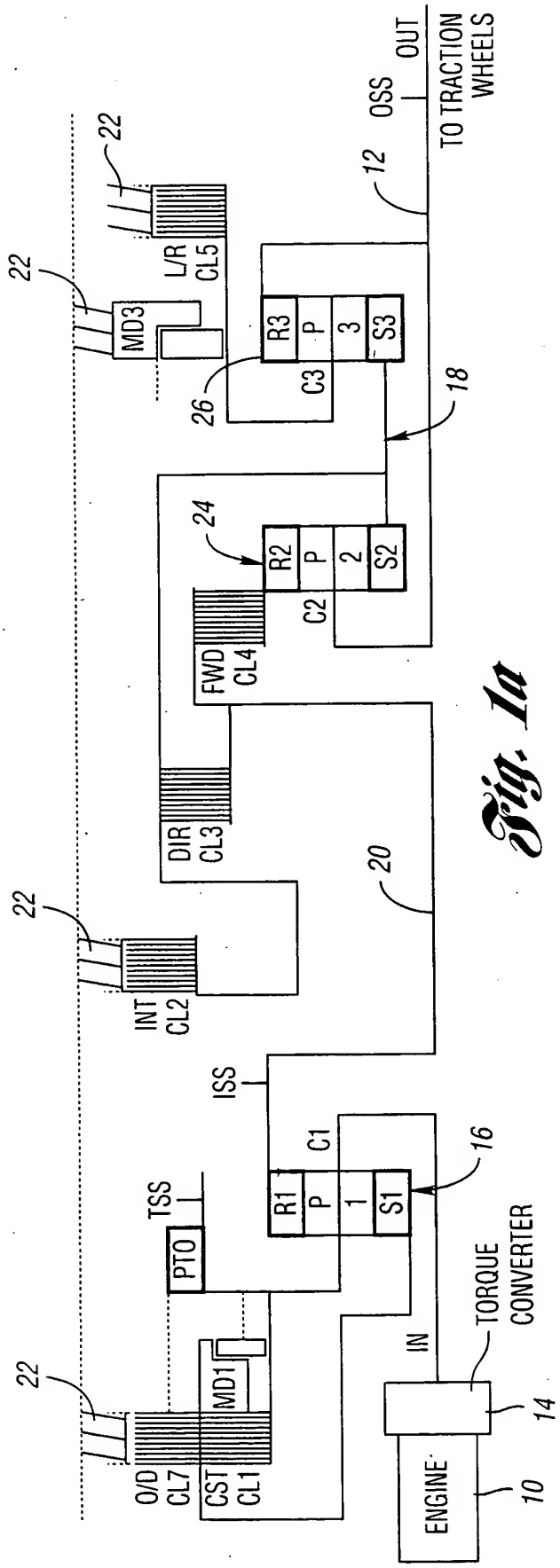


Fig. 1a

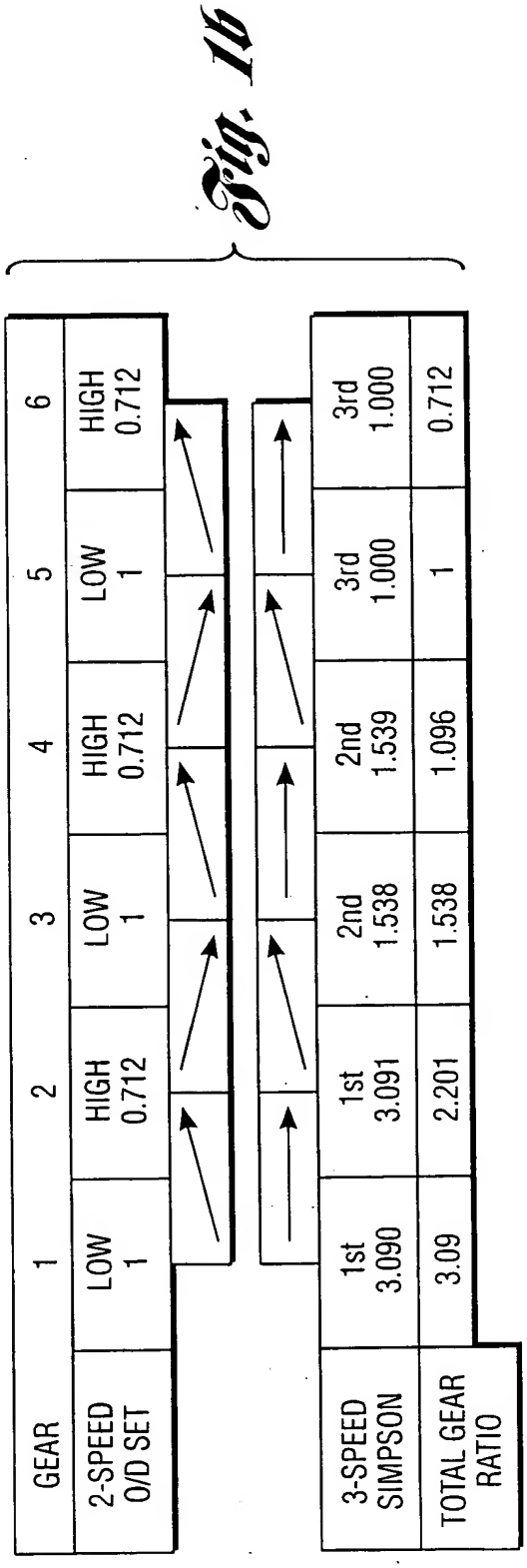
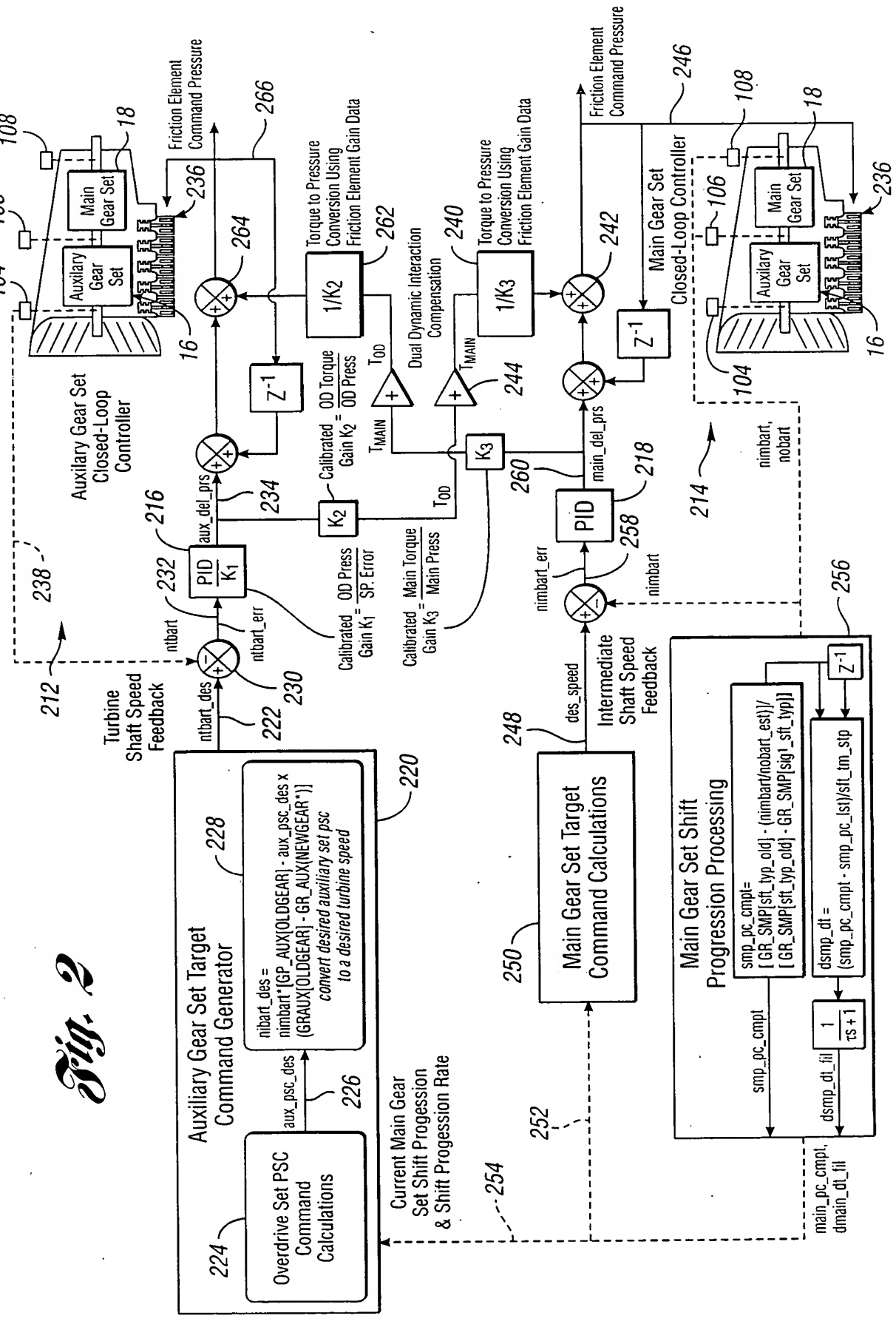


Fig. 1b


Auxiliary Gear Set Target Command Generator
Overdrive Set PSC Command Calculations
nibart_des = nimbart*[GP_AUX[OLDGEAR] - aux_psc_des x (GRAUX[OLDGEAR] - GR_AUX[NEWGEAR*])]
convert desired auxiliary set psc to a desired turbine speed
aux_psc_des
Current Main Gear Set Shift Progression & Shift Progression Rate
Main Gear Set Target Command Calculations
des_speed
Intermediate Shaft Speed Feedback
Main Gear Set Shift Progression Processing
smp_pc_cmpt= [GR_SMP[sft_typ_old] - (nimbart/nobart_est)]/ [GR_SMP[sft_typ_old] - GR_SMP[sig1_sft_typ]]
dsmp_dt = (smp_pc_cmpt - smp_pc_lst)/sft_tm_stp
smp_pc_cmpt
dsmp_dt_fil
main_pc_cmpt, dmain_dt_fil
Turbine Shaft Speed Feedback
ntbart
ntbart_des
ntbart_err
PID / K1
aux_del_prs
Auxilary Gear Set Closed-Loop Controller
Calibrated Gain K1 = OD Press / SP. Error
Calibrated Gain K2 = OD Torque / OD Press
Calibrated Gain K3 = Main Torque / Main Press
K2
K3
Dual Dynamic Interaction Compensation
TOD
TMAIN
Torque to Pressure Conversion Using Friction Element Gain Data
1/K2
1/K3
Friction Element Command Pressure
Z-1
PID
main_del_prs
nimbart_err
nimbart
nimbart, nobart
Main Gear Set Closed-Loop Controller
Auxilary Gear Set
Main Gear Set
16
18
104
106
108
214
216
218
220
222
224
226
228
230
232
234
236
238
240
242
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264
266

Fig. 2

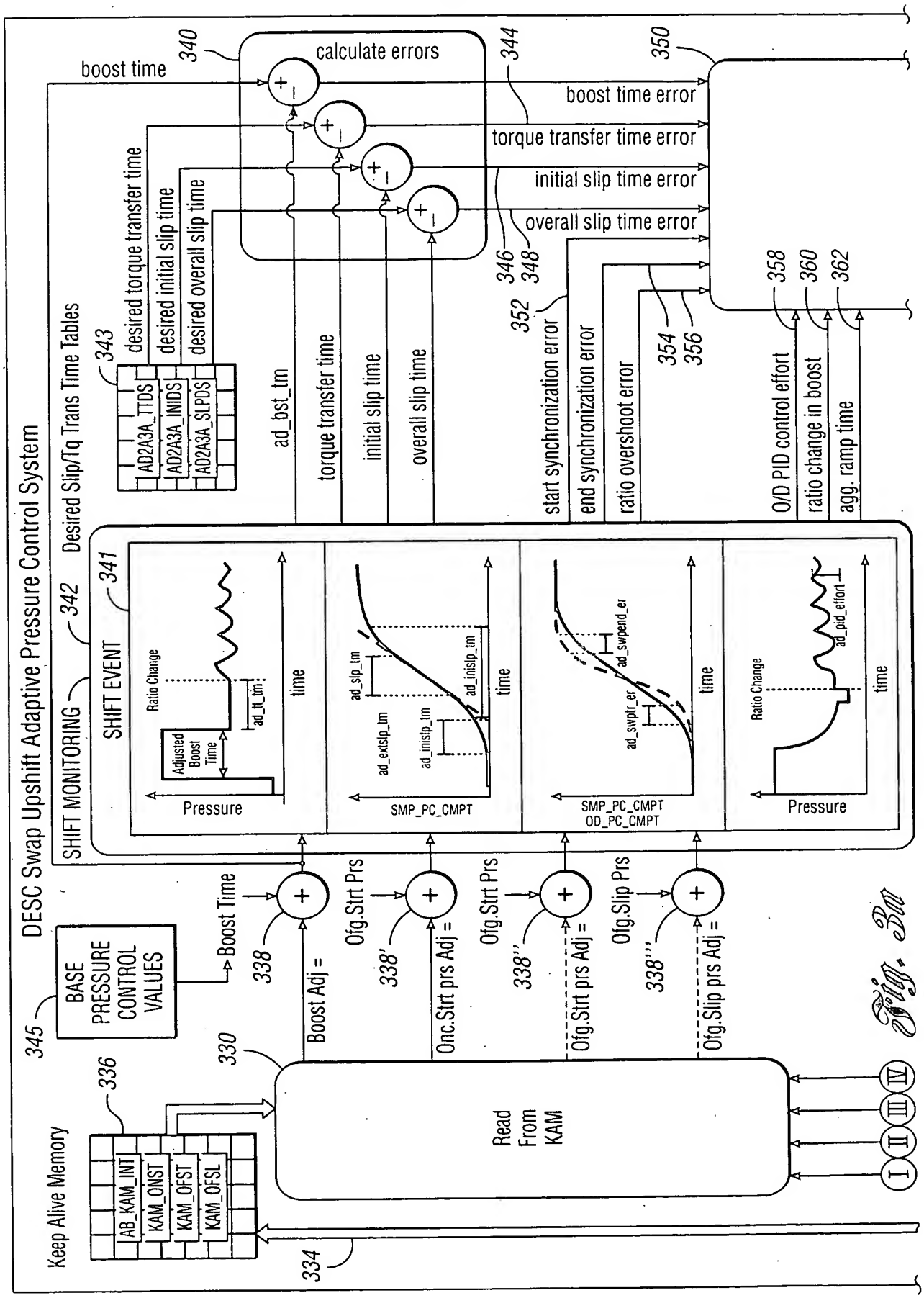

DESC Swap Upshift Adaptive Pressure Control System
Desired Slip/Tq Trans Time Tables
SHIFT MONITORING
SHIFT EVENT
342
341
343
desired torque transfer time
desired initial slip time
desired overall slip time
AD2A3A_TTDS
AD2A3A_INIDS
AD2A3A_SLPDS
boost time
340
calculate errors
344
350
boost time error
torque transfer time error
initial slip time error
overall slip time error
346
348
352
354
356
358
360
362
ad_bst_tm
torque transfer time
initial slip time
overall slip time
start synchronization error
end synchronization error
ratio overshoot error
O/D PID control effort
ratio change in boost
agg. ramp time
Ratio Change
Adjusted Boost Time
ad_tt_tm
time
Pressure
ad_slp_tm
ad_inislp_tm
ad_extslp_tm
ad_inislp_tm
SMP_PC_CMPT
ad_swpend_er
ad_swpltr_er
SMP_PC_CMPT
OD_PC_CMPT
ad_pid_effort
Boost Time
Ofg.Strt Prs
Ofg.Strt Prs
Ofg.Slip Prs
338
338'
338''
338'''
Boost Adj =
Onc.Strt prs Adj =
Ofg.Strt prs Adj =
Ofg.Slip prs Adj =
345
BASE PRESSURE CONTROL VALUES
330
Read From KAM
336
Keep Alive Memory
AB_KAM_INT
KAM_ONST
KAM_OFST
KAM_OFSL
334
I
II
III
IV

Fig. 3a

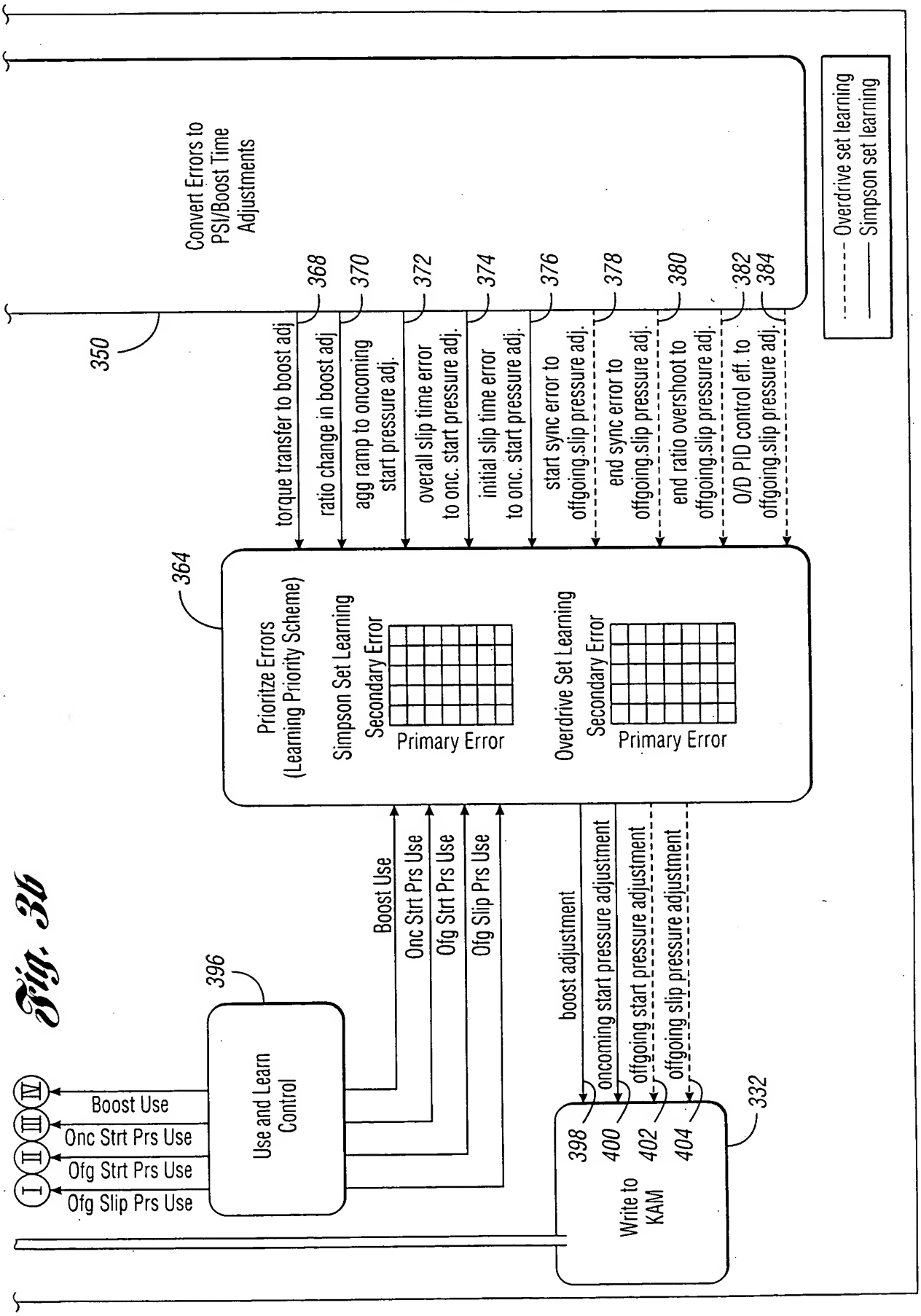

Overdrive set learning
Simpson set learning
Convert Errors to PSI/Boost Time Adjustments
350
368
370
372
374
376
378
380
382
384
torque transfer to boost adj
ratio change in boost adj
agg ramp to oncoming start pressure adj.
overall slip time error to onc. start pressure adj.
initial slip time error to onc. start pressure adj.
start sync error to offgoing.slip pressure adj.
end sync error to offgoing.slip pressure adj.
end ratio overshoot to offgoing.slip pressure adj.
O/D PID control eff. to offgoing.slip pressure adj.
364
Prioritze Errors (Learning Priority Scheme)
Simpson Set Learning Secondary Error
Primary Error
Overdrive Set Learning Secondary Error
Primary Error
Boost Use
Onc Strt Prs Use
Ofg Strt Prs Use
Ofg Slip Prs Use
boost adjustment
oncoming start pressure adjustment
offgoing start pressure adjustment
offgoing slip pressure adjustment
396
Use and Learn Control
I
II
III
IV
Boost Use
Onc Strt Prs Use
Ofg Strt Prs Use
Ofg Slip Prs Use
398
400
402
404
Write to KAM
332

Fig. 3b

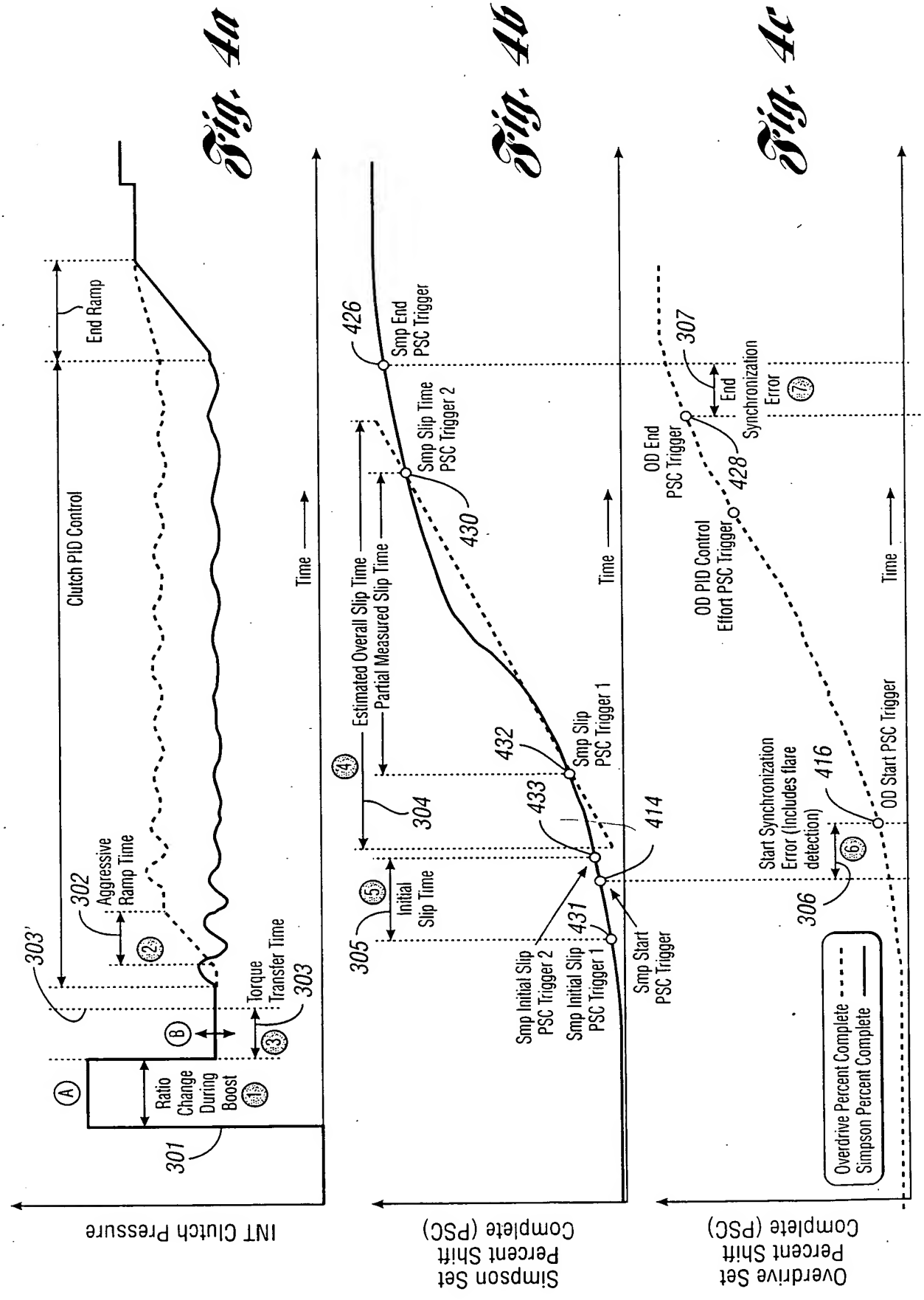


Fig. 4a
INT Clutch Pressure
Time
End Ramp
Clutch PID Control
303'
302
Aggressive Ramp Time
Torque Transfer Time
303
Ratio Change During Boost
301
A
B
1
2
3
Fig. 4b
Simpson Set Percent Shift Complete (PSC)
Time
426
Smp End PSC Trigger
Smp Slip Time PSC Trigger 2
430
Estimated Overall Slip Time
Partial Measured Slip Time
304
Initial Slip Time
305
Smp Initial Slip PSC Trigger 2
Smp Initial Slip PSC Trigger 1
431
Smp Start PSC Trigger
432
Smp Slip PSC Trigger 1
433
414
4
5
Fig. 4c
Overdrive Set Percent Shift Complete (PSC)
Time
307
End Synchronization Error
7
OD End PSC Trigger
428
OD PID Control Effort PSC Trigger
Start Synchronization Error (Includes flare detection)
306
416
OD Start PSC Trigger
6
Overdrive Percent Complete
Simpson Percent Complete

Fig. 4b

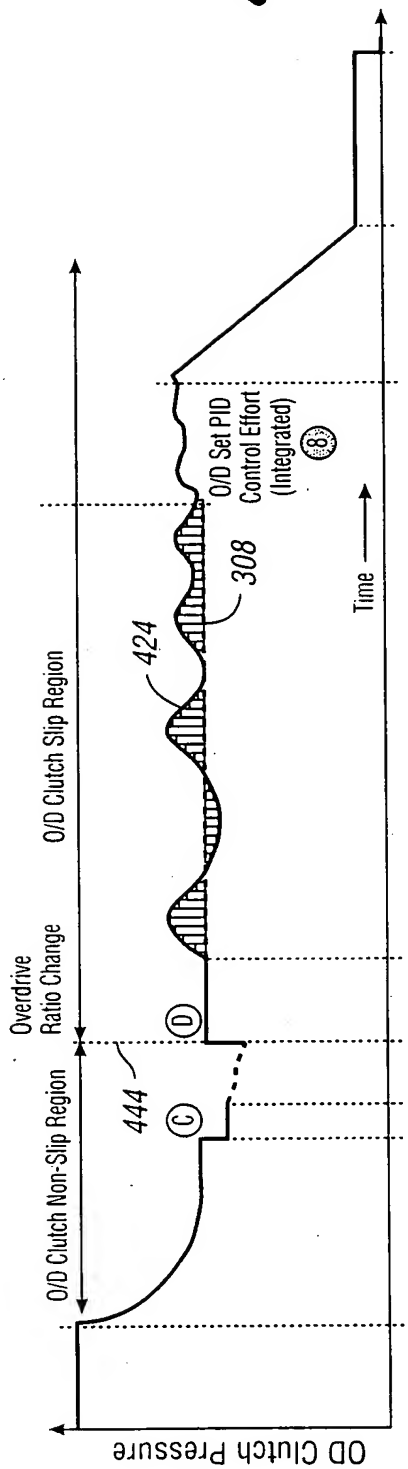


Fig. 4e

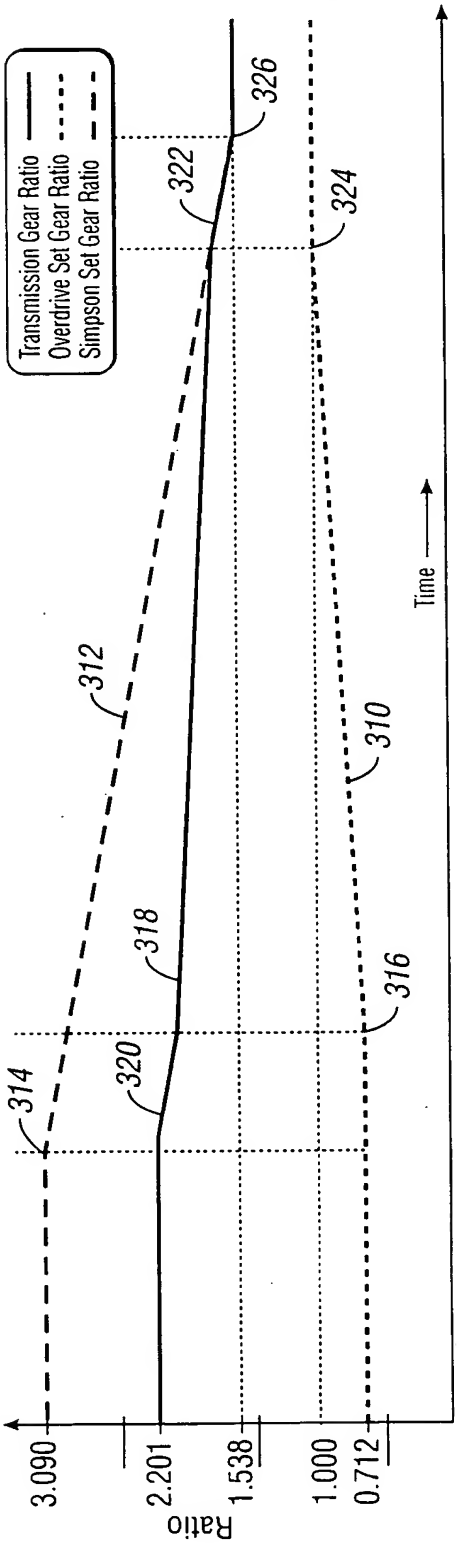
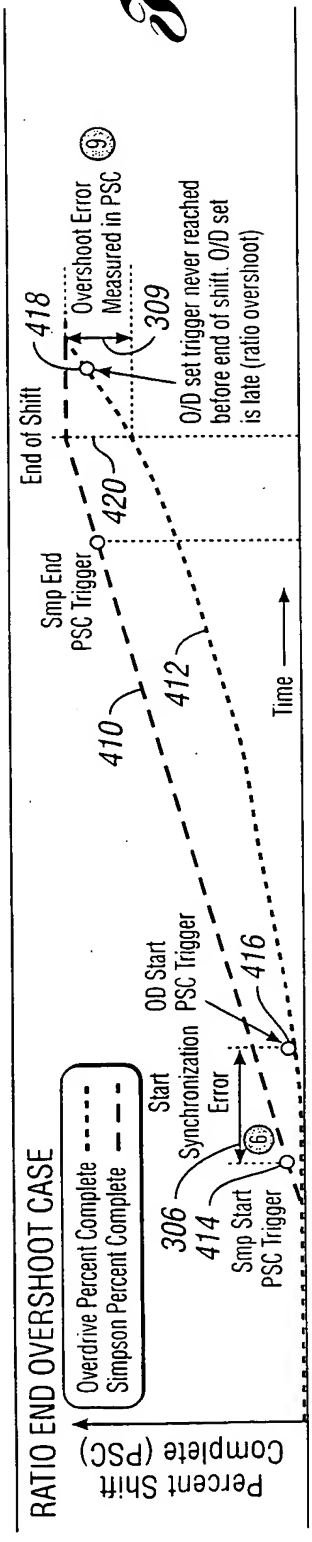


Fig. 4f



Simpson Gearset Swap-Upshift Adaptive Priority Learning Scheme - Secondary Conditions Detected

Primary Conditions Detected	① Ratio Change During Boost	② Aggressive Ramp Reached	③ Torque Trasnsfer Time Error	④ Overall Slip Time Error	⑤ Initial Slip Time Error
① Ratio Change During Boost	Adapt (A) for: ①	Adapt (A) for: ①	Adapt (A) for: ①	Adapt (A) for: ①	Adapt (A) for: ①
② Aggressive Ramp Reached	Adapt (A) for: ①	Adapt (B) for: ②	Adapt (B) for: ②	Adapt (B) for: ②	Adapt (B) for: ②
③ Troque Trasnsfer Time Error	Adapt (A) for: ①	Adapt (B) for: ②	Adapt (A) for: ③	If ITT error large, adapt (A) for ③ else adapt (A) for ③ & adapt (B) for ④	If ITT error large, adapt (A) for ③ else adapt (A) for ③ & adapt (B) for ⑤
④ Overall Slip Time Error	Adapt (A) for: ①	Adapt (B) for: ②	If ITT error large, adapt (A) for ③ else adapt (A) for ③ & adapt (B) for ④	Adapt (B) for: ④	Adapt (B) for: ④
⑤ Initial Slip Time Error	Adapt (A) for: ①	Adapt (B) for: ②	If ITT error large, adapt (A) for ③ else adapt (A) for ③ & adapt (B) for ⑤	Adapt (B) for: ④	Adapt (B) for: ⑤

Fig. 5a

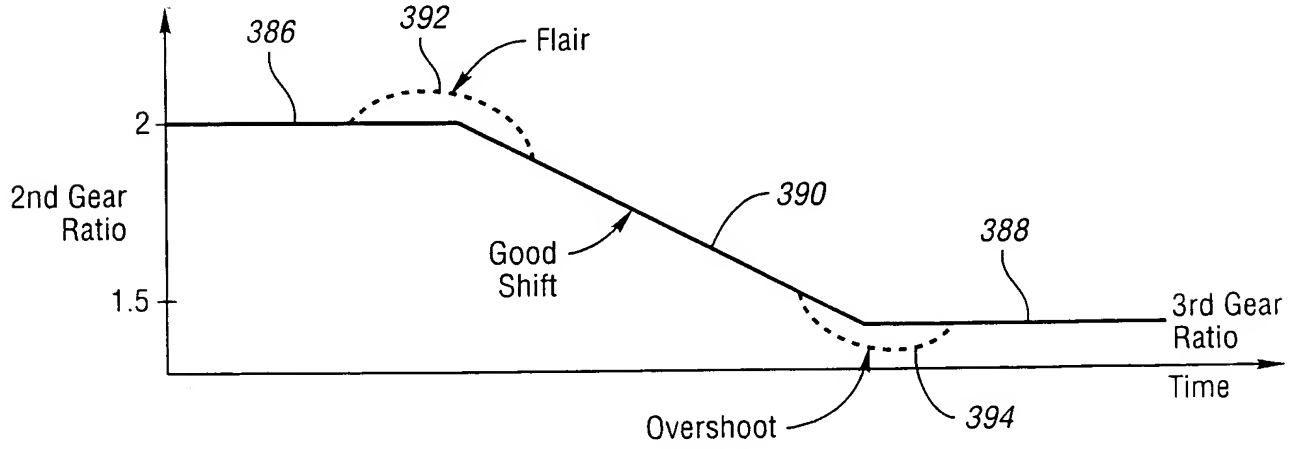


Fig. 6

Fig. 7D

Overdrive Swap-Shift Adaptive Priority Learning Scheme - Secondary Conditions Detected

Primary Conditions Detected	① Simpson Set Ratio Change During Boost	② Simpson Set Aggressive Ramp Reached	③④⑤ All Other Significant Simpson Set Adaptation On: (A) (B)	③④⑤ All Other Minimal Simpson Set Adaptation On: (A) (B)	⑥ Start Synchronization Error (includes flare detection)	⑨ Overshoot Error Measured in PSC	⑦ End Synchronization Error	⑧ O/D Set PID Control Effort (Integrated)
① Simpson Set Ratio Change During Boost	Adapt (A) for: (1)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (A) for: (1)
② Simpson Set Aggressive Ramp Reached	No O/D set Learn Adapt (A) for: (1)	Adapt (B) for: (2)	No O/D set Learn Adapt (B) for: (2)	No O/D set Learn Adapt (B) for: (2)	No O/D set Learn Adapt (B) for: (2)	No O/D set Learn Adapt (B) for: (2)	No O/D set Learn Adapt (B) for: (2)	No O/D set Learn Adapt (B) for: (2)
③④⑤ All Other Significant Simpson Set Adaptation On: (A) (B)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (B) for: (2)	Simpson Set: (3) (4) (5) Adapt (A) (B) for	Simpson Set Still Significantly Adapting, No Overdrive set Adaptation See Simpson Set Priority Scheme				
③④⑤ All Other Minimal Simpson Set Adaptation On: (A) (B)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (B) for: (2)		Simpson Set: (3) (4) (5) Adapt (A) (B) for	Simpson Set: (3) (4) (5) Adapt (A) (B) for Overdrive Set: Adapt (C) for (6)	Simpson Set: (3) (4) (5) Adapt (A) (B) for Overdrive Set: Adapt (D) for (9)	Simpson Set: (3) (4) (5) Adapt (A) (B) for Overdrive Set: Adapt (D) for (7)	Simpson Set: (3) (4) (5) Adapt (A) (B) for Overdrive Set: Adapt (D) for (8)
⑥ Start Synchronization Error (includes flare detection)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (B) for: (2)		Simpson Set: (3) (4) (5) Adapt (A) (B) for Overdrive Set: Adapt (C) for (6)	Adapt (C) for: (6)	If start sync error large, (C) apt (6) for else adapt (C) for (6) & adapt (D) for (9)	If start sync error large, (C) apt (6) for else adapt (C) for (6) & adapt (D) for (8)	If start sync error large, (C) apt (6) for else adapt (C) for (6) & adapt (D) for (8)
⑨ Overshoot Error Measured in PSC	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (B) for: (2)	Simpson Set Still Significantly Adapting, No Overdrive set Adaptation Adapt (A) (B) (3) (4) (5) See Simpson Set Priority Scheme	Simpson Set: (3) (4) (5) Adapt (A) (B) for Overdrive Set: Adapt (D) for (9)	If start sync error large, (C) apt (6) for else adapt (C) for (6) & adapt (D) for (9)	Adapt (D) for: (9)	Adapt (D) for: (9)	Adapt (D) for: (9)
⑦ End Synchronization Error	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (B) for: (2)		Simpson Set: (3) (4) (5) Adapt (A) (B) for Overdrive Set: Adapt (D) for (7)	If start sync error large, (C) apt (6) for else adapt (C) for (6) & adapt (D) for (7)	Adapt (D) for: (9)	Adapt (D) for: (7)	If end sync error large, adapt (D) for (7) else adapt (D) for (8)
⑧ O/D Set PID Control Effort (Integrated)	No O/D set Learn Adapt (A) for: (1)	No O/D set Learn Adapt (B) for: (2)		Simpson Set: (3) (4) (5) Adapt (A) (B) for Overdrive Set: Adapt (D) for (8)	If start sync error large, (C) apt (6) for else adapt (C) for (6) & adapt (D) for (8)	Adapt (D) for: (9)	If end sync error large, adapt (D) for (7) else adapt (D) for (8)	Adapt (D) for: (8)